

TIP 0410-03

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Flow from a 45° slice

Scope

The primary variables which govern the angle of outflow and contraction coefficient for a 45° slice are shown in Fig. 1. The depth B may be to a free surface or to a rigid boundary.

Fig. 2 shows the angle of outflow, β , as a function of the relative bottom lip extension and the geometric ratio b/B .

Fig. 3 is a companion chart for determining the contraction coefficient for the jet defined as $C_c = d/b$.

Safety Precautions

No safety precautions have been specified for use with this technical information paper.

Content

The information given in Figs. 2 and 3 was derived for a nonviscous, ideal fluid and can be used to predict high velocity outflows of dilute fiber suspensions in water, provided that the effects of gravity and surface tension are small and the flow is unobstructed for a distance of several times the slice opening b . Example calculations are given in TAPPI TIP 0410-02 "Flow From a Vertical Slice."

The angle of outflow and contraction coefficient were calculated from the parametric equations.

TIP Category: Data and Calculations



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$$\frac{L}{b} = 1 - 2 \left[\frac{\cos \beta \ln \left[\tan \left(\frac{\beta}{2} \right) \right] + \sin \beta \ln \left[\tan \left(\frac{\pi}{4} - \frac{\beta}{2} \right) \right] + \frac{\pi}{2} (\cos \beta + \sin \beta) + \frac{1+c^2}{c} (\tanh^{-1} c) + \frac{1-c^2}{c} (\tan^{-1} c)}{(\cos \beta - \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} + \frac{\beta}{2} \right) \right] + (\cos \beta + \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} - \frac{\beta}{2} \right) \right] + \pi \cos \beta + \frac{1+c^2}{c} \tanh^{-1} \frac{\sqrt{2} c}{1+c^2} + \frac{1-c^2}{c} \tanh^{-1} \frac{\sqrt{2} c}{1-c^2}} \right]$$

and

$$C_c = \frac{d}{b} = \left[\frac{\pi}{(\cos \beta - \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} + \frac{\beta}{2} \right) \right] + (\cos \beta + \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} - \frac{\beta}{2} \right) \right] + \pi \cos \beta + \frac{1+c^2}{c} \tanh^{-1} \frac{\sqrt{2} c}{1+c^2} + \frac{1-c^2}{c} \tanh^{-1} \frac{\sqrt{2} c}{1-c^2}} \right]$$

in which

$$c = \frac{d}{B} = \frac{C_c b}{B}$$

is a geometric ratio related to the contraction coefficient C_c . For the case that $b/B = 0$, the equations can be reduced to

$$\frac{L}{b} = 1 - 2 \left[\frac{\cos \beta \ln \left[\tan \left(\frac{\beta}{2} \right) \right] + \sin \beta \ln \left[\tan \left(\frac{\pi}{4} - \frac{\beta}{2} \right) \right] + \frac{\pi}{2} (\cos \beta + \sin \beta) + 2}{(\cos \beta - \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} + \frac{\beta}{2} \right) \right] + (\cos \beta + \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} - \frac{\beta}{2} \right) \right] + \pi \cos \beta + 2\sqrt{2}} \right]$$

and

$$C_c = \frac{d}{b} = \left[\frac{\pi}{(\cos \beta - \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} + \frac{\beta}{2} \right) \right] + (\cos \beta + \sin \beta) \ln \left[\tan \left(\frac{\pi}{8} - \frac{\beta}{2} \right) \right] + \pi \cos \beta + 2\sqrt{2}} \right]$$

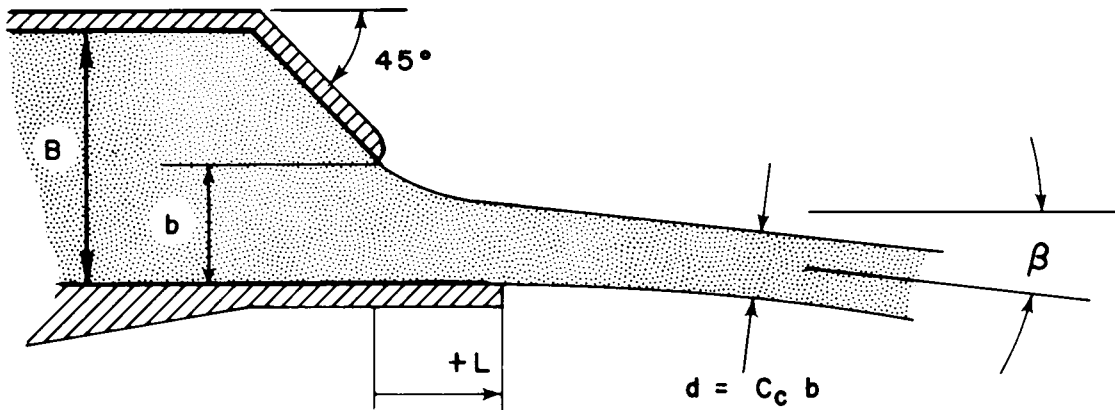


Fig. 1. Dimensions for flow from a slice.

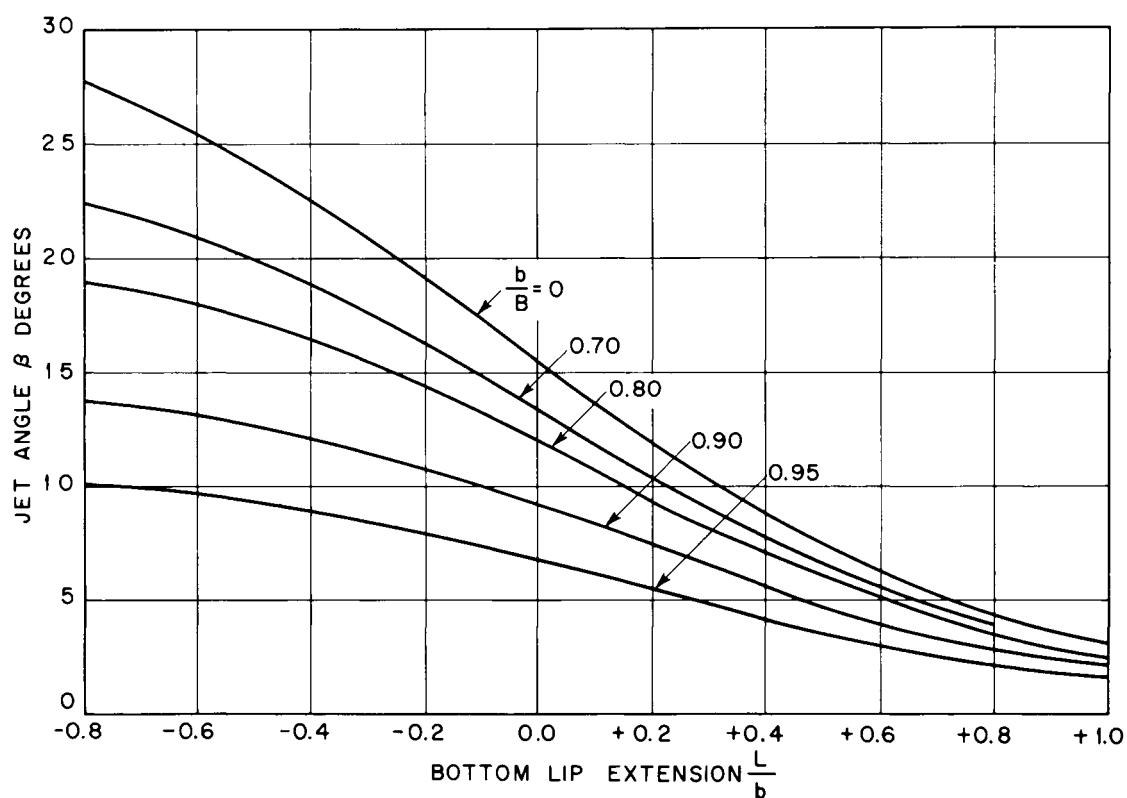


Fig. 2. Theoretical angle of outflow from a 45° slice.